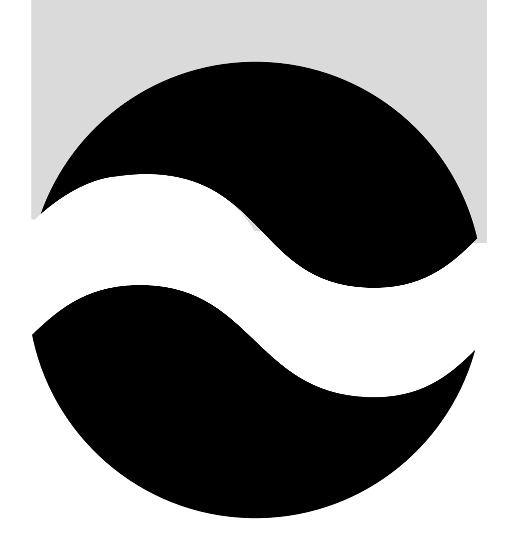


ANSI/J–STD-005
JANUARY 1995

JOINT INDUSTRY STANDARD

Requirements for Soldering Pastes







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The material in this joint standard was developed by the Solder Paste Task Group (5-24b).



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Please use the Standard Improvement Form shown at the end of this document.

JOINT

INDUSTRY

STANDARD

J-STD-005

Requirements for Soldering Pastes

A joint standard developed by the Solder Paste Task Group (5-24b) of the Institute for Interconnecting and Packaging Electronic Circuits

Users of this standard are encouraged to participate in the development of future revisions.

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Acknowledgment

Members of the Solder Paste Task Group have worked to develop this document. We would like to thank them for their dedication to this effort.

Any Standard involving a complex technology draws material from a vast number of sources. While the principle members of the Solder Paste Task Group are shown below, it is not possible to include all of those who assisted in the evolution of this Standard. To each of them, the members of the EIA and IPC extend their gratitude.

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Requirements for Soldering Pastes

1.0 SCOPE

1.1 Scope This standard prescribes general requirements for the characterization and testing of solder pastes used to make high quality electronic interconnections. This specification is a quality control document and is not intended to relate directly to the material's performance in the manufacturing process.

1.1.1 Purpose This standard defines the characteristics of solder paste through the definitions of properties and specification of test methods and inspection criteria. The materials include solder powder and solder paste flux blended to produce solder paste. Solder powders are classified as to shape of the particles and size distribution of the particles. It is not the intent of this standard to exclude particle sizes or distributions not specifically listed. The flux properties of the solder paste, including classification and testing, shall be based on J-STD-004. The requirements for solder paste are defined in general terms. In practice, where more stringent requirements are necessary, additional requirements shall be defined by mutual agreement between the user and supplier. Users are cautioned to perform tests (beyond the scope of this specification) to determine the acceptability of the solder paste for specific processes.

2.0 APPLICABLE DOCUMENTS

The following documents of the issue currently in effect, form a part of this specification to the extent specified herein.

2.1 Joint Standards[1]

J-STD-001 Soldering requirements for Electronic Interconnections (Supercedes IPC-S-815)

J-STD-004 Requirements for Soldering Fluxes (Supercedes IPC-SF-818)

J-STD-006 Requirements for Alloys and Solder Products

2.2 Military[2]

MIL-STD-45662 Calibration Systems Requirements

2.3 International Standards Organization[3]

ISO 9002 Quality Systems − Model for Quality Assurance in Production and Installation

ISO 10012-1 Quality Assurance requirements for measuring equipment—Part 1: Management of measuring equipment.

2.4 IPC[1]

IPC-A-20 Fine pitch stencil pattern for Slump.

IPC-A-21 Standard pitch stencil pattern for Slump.

IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits

IPC-TM-650 Test Methods Manual

2.2.14 Solder Powder Particle Size Distribution—Screen Method

2.2.14.1 Solder Powder Particle Size Distribution—Measuring Microscope Method

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2.4.34.3 Solder Paste Viscosity—Spiral Pump Method (Applicable at less than 300,000 centipoise)

2.4.35 Solder Paste—Slump Test

2.4.43 Solder Paste—Solder Ball Test

2.4.44 Solder Paste—Tack Test

2.4.45 Solder Paste—Wetting Test

1. Application for copies should be addressed to the IPC, 2215 Sanders Road, Northbrook, IL 60062-6135
2. Publications are available from Standardization Documents Order Dept., Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5090
3. Publications are available from the International Standards Organization 1 Rue de Varembe, Case 56, CH-1211 Geneve 20 Switzerland

2.5 American Society for Testing Materials[4]

ASTM D-1210 Fineness of Dispersion of Pigment Vehicle Systems

3.0 REQUIREMENTS

3.1 General Requirements

3.1.1 Conflict In the event of conflict between the requirements of this specification and other requirements of the applicable acquisition documents, the precedence in which documents shall govern in descending order is as follows:

1. The applicable acquisition document
2. The applicable specification sheet/drawing
3. This standard
4. Applicable referenced documents (see paragraph 2.0)

3.1.2 Terms and Definitions Definitions applicable to this specification shall conform to IPC-T-50, J-STD-001, J-STD-004, and as follows. The terms and definitions are in accordance with IPC-T-50.

3.1.2.1 Centipoise A cgs unit of the measure of viscosity equal to 1/100 poise. See viscosity.

3.1.2.2 Drying Ambient or heating process to evaporate volatile components from solder paste which may, or may not, result in melting of rosin/resin.

3.1.2.3 Micron Equal to 1 x 10^{-6} meters or 39.4 x 10^{-6} inches.

3.1.2.4 Rheology The study of the change in form and the flow of matter, generally characterized by elasticity, viscosity, and plasticity.

3.1.2.5 Thinner (Paste) A solvent or paste system with, or without, activator which is added to solder paste to replace evaporated solvents, adjust viscosity, or reduce solids content.

3.1.2.6 Viscosity The internal friction of a fluid, caused by molecular attraction, which makes it resist a tendency to flow. Expressed in dyne-seconds per cm^2 (poise) or centipoise.

3.2 Standardized Description for Products The solder paste product shall be described as outlined in Table 1.

3.2.1 Alloy Composition The percentage of each element in an alloy shall be determined by any standard analytical procedure. Wet chemistry shall be used as the reference procedure.

Table 1 Standardized Solder Paste Description

Alloy Designation	Flux Classification*	Powder Size Type	Nominal Metal Content	Viscosity
Designation from J-STD-006	Classification from J-STD-004	Type No.	% by Mass	Centipoise

*As defined and determined in J-STD-004 for low (L), moderate (M), and high (H) activity of the flux residues.

3.2.2 Flux Characterization and Inspection The fluxes in solder pastes shall be characterized by the manufacturer in accordance with the flux characterization requirements specified in J-STD-004 and shall be inspected in accordance with the flux inspection requirements of J-STD-004. The results of these inspections should be recorded on the report form included in J-STD-004 and the flux type shall be recorded on the solder paste report form.

3.3 Solder Powder Particle Size

3.3.1 Powder Size Determination Powder size determination using alternate test procedures shall be agreed upon by user and vendor.

3.3.2 Powder Size When tested in accordance with paragraph 3.3.2.1, the powder size shall be classified by type as per a standard sieve size or nearest sieve size shown which matches Tables 2A or 2B dimensions.

3.3.2.1 Maximum Powder Size (Fineness of Grind) The maximum powder size shall be determined with a fineness of grind gauge (Hegmann) type CMA 185, or equivalent, in accordance with ASTM D-1210 or IPC-TM-650, method 2.2.14.3.

3.3.2.2 Solder Powder Powder particle size distribution shall be determined by IPC-TM-650, Test Method 2.2.14, Test Method 2.2.14.1, or Test Method 2.2.14.2.

3.3.3 Solder Powder Particle Shape

3.3.3.1 Powder Shape Solder powder shape shall be spherical with maximum length-to-width ratio of 1.5 when tested in accordance with paragraphs 3.3.3.1.1 and 3.3.3.1.2. Other shapes shall be acceptable if agreed upon by user and vendor.

3.3.3.1.1 Determination of Solder Powder Particle Shape Solder powder particle shape shall be determined by visual observation of the powder with a binocular microscope at a magnification sufficient to determine the percentage that are spherical or elliptical (length-to-width ratio of less than 1.5). Powder with 90% of the particles

4. American Society for Testing Materials, 1916 Race Street, Philadelphia, PA 19103-1187

Table 2A % of Sample by Weight—Nominal Size

Type	None Larger Than	Less Than 1% Larger Than	80% Minimum Between	10% Maximum Less Than
1	160 Microns	150 Microns	150-75 Microns	20 Microns
2	80 Microns	75 Microns	75-45 Microns	20 Microns
3	50 Microns	45 Microns	45-25 Microns	20 Microns

Table 2B % of Sample by Weight—Nominal Sizes

Type	None Larger Than	Less Than 1% Larger Than	90% Minimum Between	10% Maximum Less Than
4	40 Microns	38 Microns	38–20 Microns	20 Microns
5	30 Microns	25 Microns	25–15 Microns	15 Microns
6	20 Microns	15 Microns	15–5 Microns	5 Microns

that are spherical shall be classified as spherical; all other powders shall be classified as non-spherical.

3.3.3.1.2 Solder Powder Roundness Solder powder roundness is determined with a light beam scatter and shall be classified as spherical if the deviation is 1.0 (perfectly spherical) to 1.07. Powders with values above 1.07 shall be classified as non-spherical.

3.4 Metal Percent The metal content should be between 65-96% as specified in weight percent when tested in accordance with IPC-TM-650, method 2.2.20. The metal percent shall be within +/-1% of the nominal value specified on the user's purchase order.

3.5 Viscosity The measured viscosity shall be within +/-10% of the value specified by the user. The measurement and test conditions shall be in accordance with paragraph 3.5.1.

3.5.1 Methods of Determining Viscosity The methods for determining the viscosity of solder paste in the range of 300,000 to 1,600,000 centipoise shall be in accordance with IPC-TM-650, method 2.4.34 or method 2.4.34.2. The method for determining viscosity of solder paste in the range of 50,000 to 300,000 centipoise shall be in accordance with IPC-TM-650, method 2.4.34.1 or method 2.4.34.3.

3.6 Slump Test Unless otherwise specified in the contract or purchase order, slump is assessed using two stencil thicknesses and three pad (deposit) sizes in accordance with paragraphs 3.6.1 and 3.6.2.

3.6.1 Test with 0.2 mm Thick Stencil The 0.63 x 2.03 mm pads of IPC-A-21 (see Figure 1) when tested in accordance with paragraph 5.2.1 in IPC-TM-650, method 2.4.35 should show no evidence of bridging between pads when spacing is 0.56 mm or greater. When tested in accordance with paragraph 5.2.2 in IPC-TM-650, method 2.4.35 the specimen shall show no evidence of bridging between pads when the spacing is 0.63mm or greater. The 0.33 x 2.03 mm pads (Figure 1) of the IPC-A-21 pattern when tested as per paragraph 5.2.1 in IPC-TM-650, method 2.4.35, shall show no evidence of bridging at spacing of 0.25 mm or greater and when tested as per paragraph 5.2.2 of IPC-TM-650, method 2.4.35, shall show no evidence of bridging at spacing of 0.30 mm or greater.

3.6.2 Test with 0.1 mm Thick Stencil The 0.33 mm x 2.03 mm pads of IPC-A-20 (see Figure 2) when tested in accordance with paragraph 5.2.1 in IPC-TM-650, method 2.4.35 should show no evidence of bridging at spacing of 0.25 mm or greater and when tested as per paragraph 5.2.2 of IPC-TM-650, method 2.4.35, shall show no evidence of bridging at spacing at 0.30 mm or greater.

The 0.2 mm x 2.03 mm pads (Figure 2) of the IPC-A-20 pattern when tested in accordance with paragraph 5.2.1 in IPC-TM-650, method 2.4.35 shall show no bridging at spacing of 0.175 mm or greater and when tested in accordance with paragraph 5.2.2 of IPC-TM-650, method 2.4.35, shall show no evidence of bridging at spacing of 0.20 mm or greater.

3.7 Solder Ball Test The solder paste when tested in accordance with the applicable method listed below shall meet the requirements specified.

3.7.1 Type 1-4 Powder The solder paste with Type 1 through 4 type powder defined in IPC-TM-650, method 2.4.43, shall meet the acceptance criteria presented in Figure 3. In addition, individual solder balls of greater than 75 microns shall not form on more than one of the three test patterns used in the evaluation.

3.7.2 Type 5-6 Powder The solder paste with Type 5 through 6 type powder as defined in IPC-TM-650, method 2.4.43, shall meet the acceptance presented in Figure 3. In addition, individual solder balls of greater than 50 microns shall not form on more than one of the three test patterns used in the evaluation.

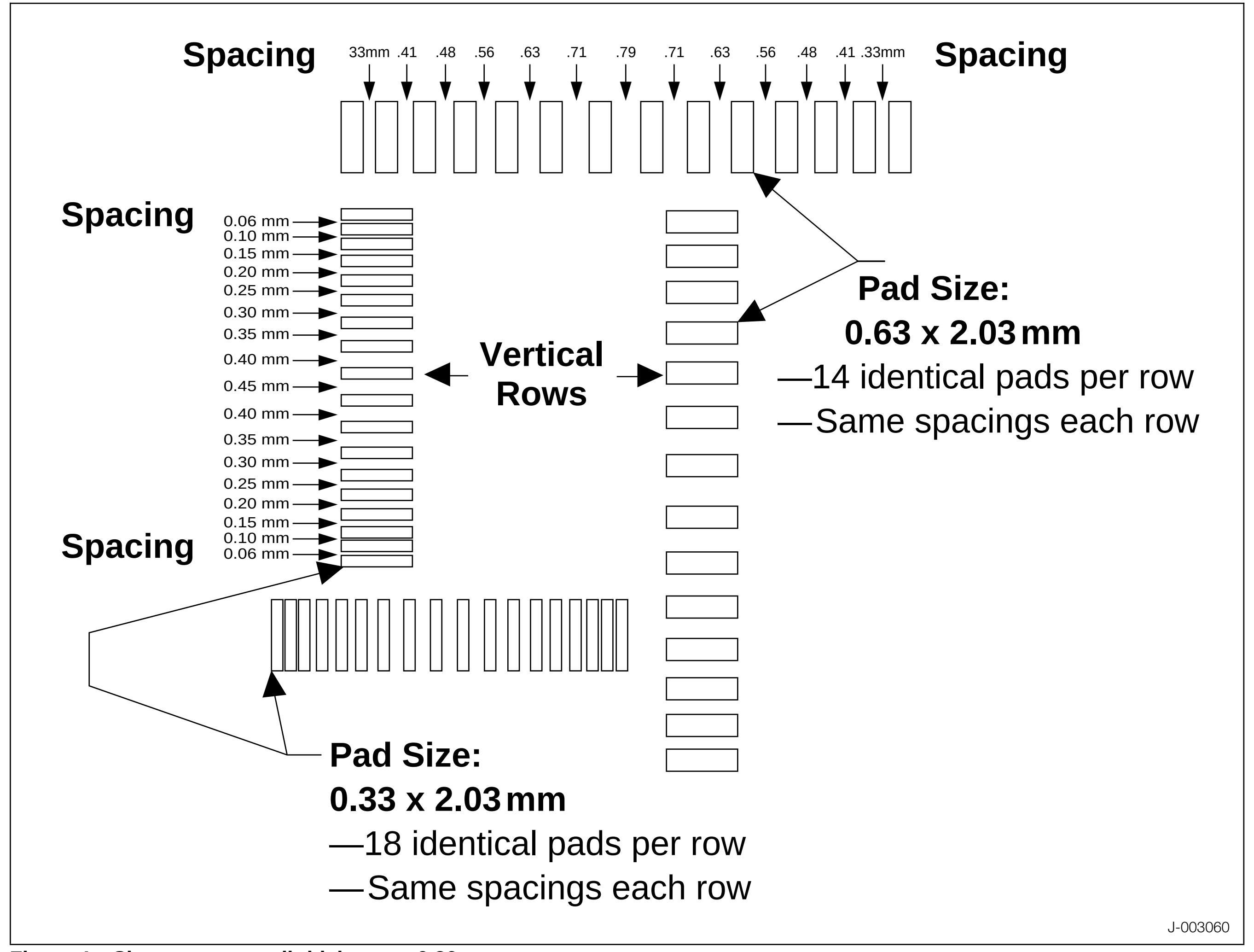


Figure 1 Slump test stencil thickness—0.20 mm

3.8 Tack Test The solder paste shall be tested in accordance with IPC-TM-650, method 2.4.44. Minimum holding force and time shall be agreed upon by user and vendor.

3.9 Wetting When tested in accordance with IPC-TM-650, method 2.4.45, the solder paste shall uniformly wet the copper coupon without evidence of dewetting or non-wetting.

3.10 Labelling The manufacturer shall label each container of solder paste with the following:

a. The manufacturer's name and address.
b. The solder paste classification (type designation), and the manufacturer's designation of the solder paste, if different.
c. The net mass of solder paste.
d. The batch number.
e. The date of manufacture.
f. All required health and safety warnings.
g. Percent metal.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection The solder paste manufacturer is responsible for the performance of all inspection specified herein except the performance inspections which are the responsibility of the user. The solder paste manufacturer may use its own or any other facilities suitable for the performance of the inspections specified herein, unless disapproved by the user. The user reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure that supplies and services conform to prescribed requirements.

4.1.1 Responsibility for Compliance Materials covered by this specification shall meet all requirements of Section 3. The inspection(s) excluding the performance inspections defined in this specification shall become a part of the contractor's overall inspection system or quality program. The vendor has responsibility of ensuring that all products or supplies submitted to the user for acceptance comply with all requirements of the purchase order contract.

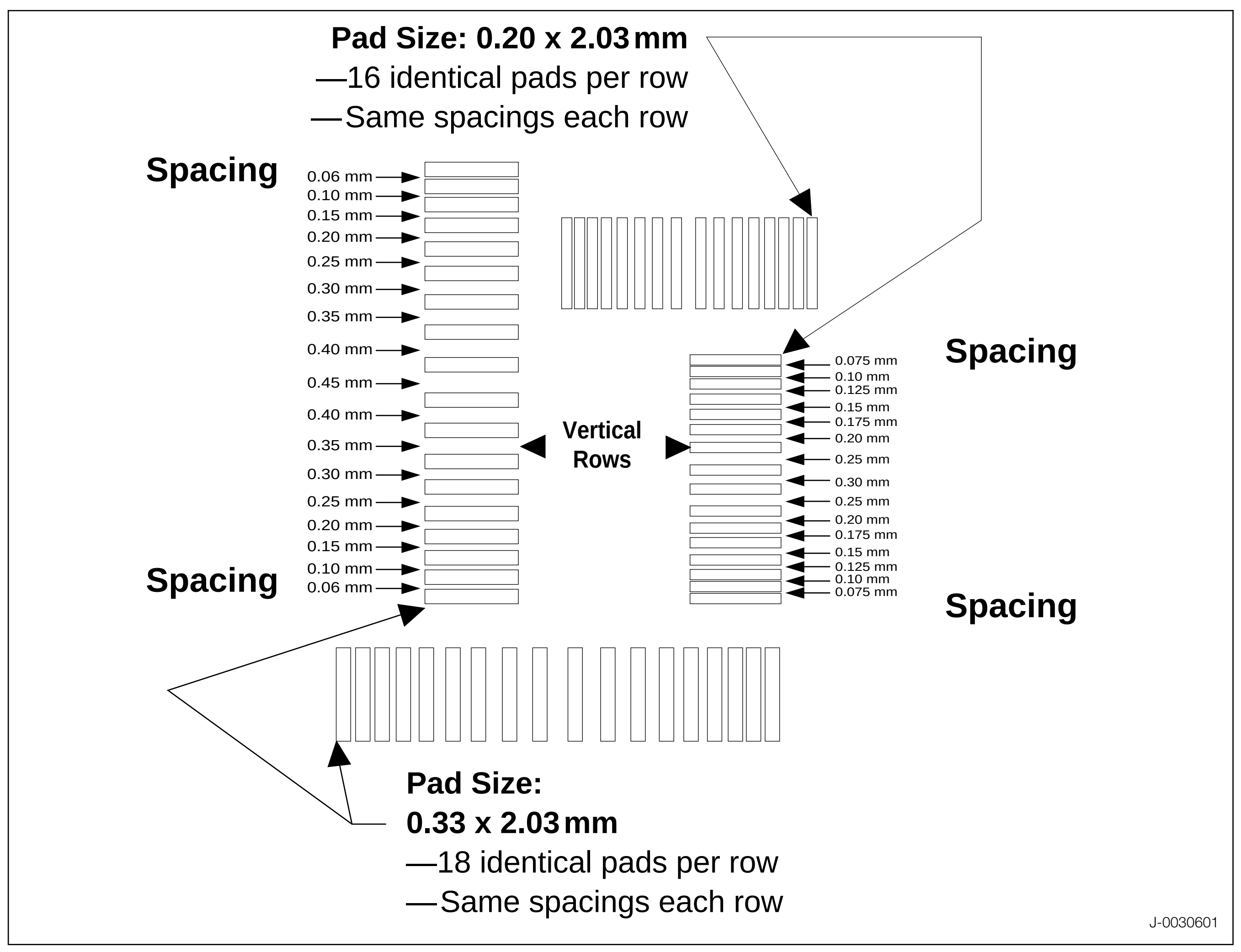


Figure 2 Slump test stencil thickness 0.10 mm

4.1.1.1 Quality Assurance Program When required by the user, a quality assurance program for material furnished under this specification shall be established and maintained in accordance with ISO 9002, or as otherwise agreed on between user and manufacturer, and shall be monitored by the qualifying activity.

4.1.2 Test Equipment and Inspection Facilities Test/measuring equipment and inspection facilities, of sufficient accuracy, quality, and quantity to permit performance of the required inspection(s), shall be established and maintained or designated by the supplier. Establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-STD-45662.

4.1.3 Inspection Conditions Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in Section 3.

4.2 Classification of Inspections The inspections specified herein are classified as follows:

1. Qualification Inspection (4.4)
2. Quality Conformance (4.5)

4.3 Inspection Report Form Figure 4 is a report form suitable, and recommended, for recording the results of solder paste inspections. Where definitive test results are not required or appropriate, successful completion of inspections should be indicated by checkmarks on the solder paste report form.

4.4 Qualification Inspection Qualification inspection shall be performed at a laboratory acceptable to the user on samples produced with equipment and procedures normally used in production.

4.4.1 Sample Size A minimum of two 300 to 500 g containers of solder paste shall be submitted for qualification inspection.

4.4.2 Inspection Routine The sample shall be subjected to the inspections specified in Table 3.

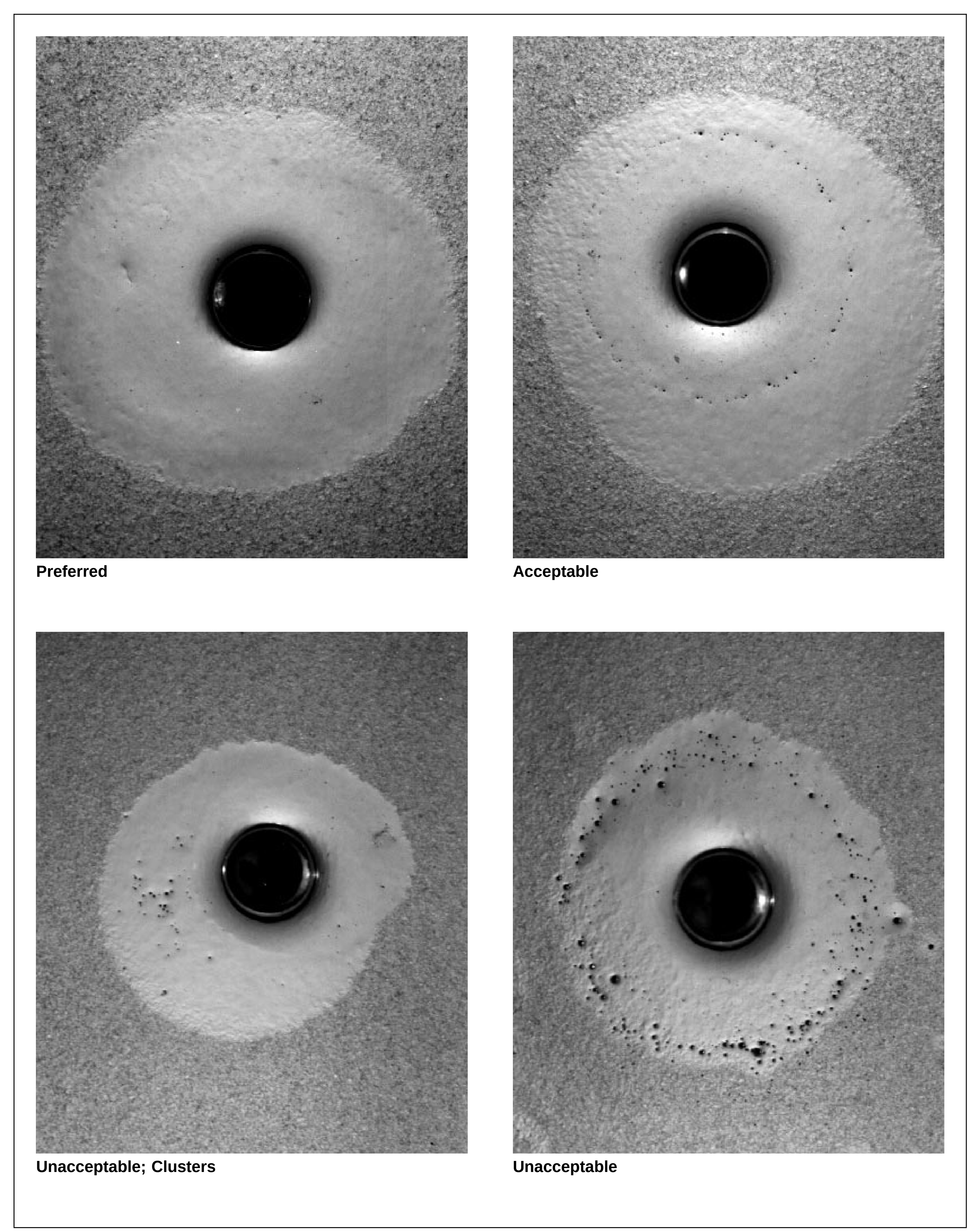


Figure 3 Solder ball test standards

Test Report on Solder Paste

(Enter appropriate information in top portion of report and complete report by entering the test results or checkmarks in the appropriate spaces.)

Inspection Purpose:

___ Qualification

___ Qualify Conformance A

___ Qualify Conformance B

___ Shelf-Life Extension

___ Performance

QPL I.D. Number ________________

Manufacturer's Identification ________________

Manufacturer's Batch Number: ________________

Date of Manufacture ________________

Original USE-By Date: ________________

Revised USE-BY Date: ________________

Date Inspection Completed: ________________ Overall Results: ___ Pass ___ Fail

Inspection performed by: ________________ Witnessd by: ________________

Inspections	Requirement Paragraph	User's Actual Require-ment	Test Result	P/F (*)	Tested by & Date
Material					
Visual					
Metal Content	3.4				
Viscosity	3.5				
Solder Ball	3.7				
Slump	3.6				
Alloy					
Flux					
Powder Size	3.3				
%in Top Screen					
% in Next Screen					
% in Bottom Screen					
% in Receiver Bottom					
Max. Powder Size	3.3.3.2.1				
Powder Shape	3.3.3.1				
Tack	3.8				
Wetting	3.9				

*P/F = Pass/Fail; enter P if test results are within tolerance of actual requirement; otherwise, enter F.

Figure 4 Solder Paste Inspection Report Form

Table 3 Solder Paste Inspection

Inspection	Qualification
Visual	X
Material	X
Metal Content	X
Viscosity	X
Solder Ball	X
Slump	X
Alloy Composition	X
Flux Characterization	X
Flux Characteristics	X
Powder Size	X
Maximum Powder Size	X
Powder Shape	X
Tack	X
Wetting	X

4.5 Quality Conformance The material manufacturer shall perform those inspections necessary to insure that the process is in control and to insure that the product is within specification limit.

4.5.1 Sampling Plan Statistical sampling and inspection shall be in accordance with an approved quality program. (See 4.1.1.1).

4.5.2 Rejected Lots If an inspection lot is rejected, the supplier may rework it to correct the defects, or screen out the defective units and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

5.0 PREPARATION FOR DELIVERY

Preservation packaging, packing and marking for shipment, and identification shall be as specified in the contract or purchase order.

6.0 NOTES

6.1 This document is intended to be applicable to all types of solder paste as used for soldering in general and to soldering in electronics particularly. The solder pastes involved relate to all aspects of application.

6.2 Shelf Life If the stated shelf life on a product is expired, but it meets the performance tests, it may be used. If the material is requalified, the new shelf life shall be considered to be half the stated shelf life.

6.2.1 Performance and Shelf-life Extension Inspections The performance and shelf life extension inspections have been included herein for user benefit. Performance inspections provide the user with a set of inspections which can help in assessing how well the solder products will perform in a particular application. Shelf life extension inspections provide the user with a set of inspections which can help in assessing whether or not a particular batch of solder paste will be usable past its normal shelf life. Recommended performance and shelf life extension inspections are listed in Table 4. These inspections are performed in accordance with 3.0.

Table 4 User Inspection for Solder Paste

Inspections	Performance	Shelf life extension
Visual	X	X
Viscosity	X	X
Solder Ball	X	
Slump	X	
Tack	X	
Wetting	X	

The Institute for Interconnecting and Packaging Electronic Circuits
2215 Sanders Road • Northbrook, IL 60062



IPC-TM-650
TEST METHODS MANUAL

Number	
2.2.14	
Subject: **Solder Powder Particle Size Distribution—Screen Method for Types 1-4**	
Date: **1/95**	Revision
Originating Task Group: **Solder Paste Task Group (5-24b)**	

1.0 Scope A method for determining whether or not the powder in a solder paste complies with the relevant powder type. The ASTM B-214 standard screen powder size distribution method has been found to be acceptable.

2.0 Applicable Documents

ASTM E11

BS.410

DIN 4188

ISO 565

ISO 3310

3.0 Test Specimen

Approximately 150 grams of solder paste

4.0 Equipment/Apparatus

Vibratory test sieving machine

Test sieves to BS.410, ASTM E11, DIN 4188, or ISO 565 and ISO 3310 with mesh openings of 150, 75, 45, 38, 25 and 20 micrometers

Sieve bottom receiver and lid

Balance (scale) with an accuracy of 0.01 g

Beaker 400–600 ml

Watch glass

Solvent

Acetone

Spatula

5.0 Procedure

5.1 Preparation

5.1.1 Wait, if necessary, until the solder paste is at room temperature.

5.2 Test

5.2.1 Homogenize the paste by stirring with the spatula.

5.2.2 Weigh paste containing approximately 110 g of solder alloy into the carefully cleaned beaker.

5.2.3 Add approximately 50 ml solvent.

5.2.4 Stir the mixture with the spatula so that the flux in the paste can dissolve in the solvent.

5.2.5 Cover the beaker with the watch glass.

5.2.6 Let the beaker with the watch glass stand until the solder powder settles.

5.2.7 Decant, carefully, as much as possible of the fluid without losing any of the solder powder.

5.2.8 Repeat the extraction procedure five times, using 50 ml solvent for each extraction.

5.2.9 Add approximately 50 ml acetone to the washed solder powder and stir with the spatula to assist in drying.

5.2.10 Let the solder powder settle.

5.2.11 Decant, carefully, as much as possible of the acetone.

5.2.12 Repeat the acetone wash 2 additional times.

5.2.13 Allow the powder to dry at ambient temperature until the weight is constant.

5.2.14 Weigh test sieves, with mesh opening sizes appropriate for the type of powder being tested, and the sieve bottom receiver. Typical sieves required are shown in Table 1.

5.2.15 Place the sieves on the receiver with the sieve with the smallest opening on the receiver and processing sequentially upward to the largest opening screen.

Table 1 Screen Opening

Type 1	150	75	20
Type 2	75	45	20
Type 3	45	25	20
Type 4		38	20

Table 2A % of Sample by Weight—Nominal Sizes

	Less Than 1% Larger Than	80% Minimum Between	10% Maximum Less Than
Type 1	150 Microns	150–75 Microns	20 Microns
Type 2	75 Microns	75–45 Microns	20 Microns
Type 3	45 Microns	45–25 Microns	20 Microns

Table 2B % of Sample by Weight—Nominal Sizes

	Less Than 1% Larger Than	90% Minimum Between	10% Maximum Less Than
Type 4	38 Microns	38−20 Microns	20 Microns

5.2.16 Weigh the powder and put this in the top sieve.

5.2.17 Place the lid on the sieve combination and transfer this to the sieving machine.

5.2.18 Run the machine for approximately 40 minutes.

5.2.19 Reweigh the sieves and the receiver.

5.2.20 Subtract the original weights of the sieves and the receiver to obtain the weights of powder with sizes greater than, within, and less than the nominal size range from Table 2A and 2B.

5.3 Evaluation Express the masses of the powder above, within, and below the nominal size range as percentages of the mass of the original sample. Enter data in Table 3.

Table 3

Type 1	+150µm ______	+75 µm ______	+20 µm ______	–20 µm ______
Type 2	+ 75 µm ______	+45 µm ______	+20 µm ______	–20 µm ______
Type 3	+ 45 µm ______	+25 µm ______	+20 µm ______	–20 µm ______
Type 4	+ 38 µm ______	+20 µm ______	–20 µm ______	

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Number **2.2.14.1**	
Subject **Solder Powder Particle Size Distribution—Measuring Microscope Method**	
Date **1/95**	Revision
Originating Task Group **Solder Paste Task Group (5-24b)**	

1.0 Scope This test specifies a standard procedure for estimating the particle size and the particle shape of solder powder in solder pastes by microscopic methods.

2.0 Applicable Documents None

3.0 Test Specimen

1 gram of solder paste

4.0 Equipment/Apparatus

Thinner

Spatula

Beaker 30 ml

Microscope, magnification 100 times

Measuring ocular, scale division 10 µm

Microscope slides

Microscope glass cover slips

5.0 Procedure

5.1 Preparation

5.1.1 Wait, if necessary, until the solder paste is at room temperature.

5.2 Test

5.2.1 Homogenize the paste by stirring with the spatula.

5.2.2 Weigh approximately 4 g of thinner.

5.2.3 Add approximately 1 g of the solder paste.

5.2.4 Stir with the spatula until a uniform mixture has been obtained.

5.2.5 Apply a small drop on the microscope slide.

5.2.6 Cover the slide with the cover slip and press gently to spread out the small drop between the glasses.

5.2.7 Measure with the microscope the length and width of the estimated smallest and largest solder powder particles in a viewing area of approximately 50 particles. (Photographs may be used for measuring and/or reference purposes).

5.2.8 Estimate the principle shape of the particles as spherical or non-spherical.

5.3 Evaluation Express the masses of the powder above, within, and below the nominal size range as percentages of the mass of the original sample. Enter data in Table 1.

Table 1

Type 1	+150µm ______	+75 µm ______	+20 µm ______	–20 µm ______
Type 2	+ 75 µm ______	+45 µm ______	+20 µm ______	–20 µm ______
Type 3	+ 45 µm ______	+25 µm ______	+20 µm ______	–20 µm ______
Type 4	+ 38 µm ______	+20 µm ______	–20 µm ______	
Type 5	+ 30 µm ______	+15 µm ______	–15 µm ______	
Type 6	+ 15 µm ______	+ 5 µm ______	– 5 µm ______	

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TEST METHODS MANUAL

Number **2.2.14.2**	
Subject **Solder Powder Particle Size Distribution—Optical Image Analyzer Method**	
Date **1/95**	Revision
Originating Task Group **Solder Paste Task Group (5-24b)**	

1.0 Scope This test method is designed to determine powder particle size distribution in creams by image analysis.

2.0 Applicable Documents None

3.0 Test Specimen

10 grams of solder paste

4.0 Equipment/Apparatus

Thinner

5.0 Procedure

5.1 Preparation

5.1.1 Stencil some solder cream onto a glass slide using a 5 or 6 mm diameter, 0.1 mm thick stencil.

5.1.2 Apply a little thinner to the solder paste and gently disperse the paste over an area about 20 mm diameter, using a glass rod. Cover with a 22 mm diameter cover glass and gently press to give a monolayer dispersion of powder particles under the cover glass.

It is important to get a good dispersion without a lot of bubbles or particle agglomerates. If the paste you are examining has a high metal content, remove some of the stencilled paste before dispersing it. The standard stencils are suitable for 85–86% metal paste.

5.1.3 Label the glass slide with the powder batch number.

5.2 Images for Analysis The next step is to put 10 or 15 images from each sample into an image directory.

5.2.1 Start up the image analyzer.

5.2.2 Set up the microscope illumination for X10 and select the X10 objective.

5.2.3 Put the slide on the microscope, focus, swing the binocular eyepiece to the left sending the light to the TV camera, and refocus on the screen.

5.2.4 Ensure that there are no agglomerations or badly out-of-focus particles and then capture the image.

5.2.5 Capture 10 images covering the slide in a systematic way without consciously selecting areas (other than avoiding agglomerations and areas of very low particle density).

5.2.6 Record the number of the slide and remove from the microscope.

5.2.7 Put the next slide on the microscope and repeat the process.

5.2.8 When all the samples have been recovered, swing the eyepiece back and switch off the microscope.

5.2.9 Comments

– Do not change the illumination between samples.

– Record a series of samples at the same magnification.

5.3 Image Analysis

5.3.1 When images from the required number of samples have been entered, select ‘Multi Sample Size’ on the menu (or ‘One Sample Size’ for a single sample). An image in red and blue will then come up on the screen.

5.3.2 Using the left and center buttons on the mouse, adjust the thresholds until the red areas correspond to the particles to be measured. Selecting the right hand button allows you to vary the line on the screen where the intensity plot is measured. Adjust the top threshold so that it is about halfway down the intensity minima. Press center and right buttons on the mouse simultaneously.

5.3.3 You should now see a green rectangle on a grey image. If there is no rectangle, press the left hand button until one appears.

5.3.4 A particle is measured if the top of the particle lies within the rectangle, so the size and position of the rectangle must be adjusted so that the sides are half a particle diameter from the sides of the screen, and the base of the rectangle a whole particle diameter from the bottom of the screen. The top of the rectangle should lie along the top of the screen. The middle button on the mouse swaps between ‘moving’ and ‘growing’ the rectangle. When the rectangle is set, press the right hand button on the mouse to proceed.

Table 1

Type 1	+150µm ______	+75 µm ______	+20 µm ______	–20 µm ______
Type 2	+ 75 µm ______	+45 µm ______	+20 µm ______	–20 µm ______
Type 3	+ 45 µm ______	+25 µm ______	+20 µm ______	–20 µm ______
Type 4	+ 38 µm ______	+20 µm ______	–20 µm ______	
Type 5	+ 30 µm ______	+15 µm ______	–15 µm ______	
Type 6	+ 15 µm ______	+ 5 µm ______	– 5 µm ______	

5.3.5 On the keyboard that now comes up on the screen, select the number of samples being processed.

5.3.6 On the next keyboard select the number of particles to be measured (200 for type 1-4 and 400 for type 5-6 is suggested).

5.3 Evaluation Express the masses of the powder above, within, and below the nominal size range as percentages of the mass of the original sample. Enter data in Table 1.

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Number **2.2.14.3**	
Subject **Determination of Maximum Solder Powder Particle Size**	
Date **1/95**	Revision
Originating Task Group **Solder Paste Task Group (5-24b)**	

1.0 Scope This test method is designed to determine the maximum (average) solder particle size in a solder paste using a fineness of grind gauge.

2.0 Applicable Documents

ASTM D-1210-79 Fineness of Dispersion of Pigment-Vehicle Systems

3.0 Test Specimen At least 100 grams of uniformly mixed solder paste.

4.0 Equipment/Apparatus Gauge-Hegman Type CMA 185*, or equivalent, in accordance with ASTM D1210-79. A hardened steel, stainless steel, or chrome-plated steel block approximately 175 mm in length, 65 mm in width, and 13 mm thick.

The top surface of the block shall be ground smooth and flat and shall contain one or two grooves 140 mm in calibrated length and 12.5 mm wide parallel to the longer sides of the block.

Each groove shall be tapered uniformly in depth lengthwise from a suitable depth (for example 50 to 100 micrometers) at 10 mm from one end to zero depth at the other with intermediate calibrations in accordance with the depth at these points.

Scraper—A single- or double-edged hardened steel, stainless steel, or chrome-plated steel blade 90 mm long, 38 mm wide, and 6.4 mm thick. The edge or edges on the long sides shall be straight and rounded to a radius of approximately 0.38 mm.

5.1 Test

5.1.1 Using a fineness of grind gauge (Hegman) Type CMA 185 or equivalent in accordance with ASTM D-1210 determine the maximum and average particle size of the powder.

5.2 Evaluation Acceptance of each type of powder shall be based on the specifications listed in Table 1. Enter the results in Table 2 ‘‘Test Report on Solder Paste.’’

*Source: Precision Gage & Tool Co. 28 Volkenand Ave., Dayton, Ohio 45410 513/254-8404

Table 1

	1st	4th	Major
Type 1	160µm	150 µm	140 µm
Type 2	80µm	75 µm	65 µm
Type 3	50µm	45 µm	40 µm
Type 4	40µm	38 µm	35 µm
Type 5	30µm	25 µm	23 µm
Type 6	20µm	15 µm	15 µm

Table 2 Test Report on Solder Paste

Enter appropriate information in top portion of report and complete report by entering the test results or checkmarks in the appropriate spaces.

Inspection Purpose:
- __ Qualification
- __ Quality Conformance A
- __ Quality Conformance B
- __ Shelf-Life Extension
- __ Performance

QPL I.D. Number: ____________________
Manufacturer's Identification: ____________________
Manufacturer's Batch Number: ____________________
Date of Manufacture: ____________________
Original Use-By Date: ____________________
Revised Use-By Date: ____________________

Date Inspection Completed: ____________________ Overall Results: __ Pass __ Fail
Inspection Performed by: ____________________ Witnessed by: ____________________

Inspections	User's Actual Requirement	Test Result	P/F (*)	Tested by & Date
Material				
Visual				
Metal Content				
Viscosity				
Solder Ball				
Slump				
Alloy				
Flux				
Powder Size				
% In Top Screen				
% In Next Screen				
% In Bottom Screen				
% In Receiver Bottom				
Max. Powder Size				
Powder Shape				
Tack				
Wetting				

* P/F = PASS/FAIL; enter P if test results are within tolerance of actual requirement; otherwise, enter F

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TEST METHODS MANUAL

Number	
2.2.20	
Subject	
Solder Paste Metal Content by Weight	
Date 1/95	Revision
Originating Task Group	
Solder Paste Task Group (5-24b)	

1.0 Scope This procedure determines the percent metal content for solder paste.

2.0 Applicable Documents None

3.0 Test Specimen 50 grams of solder paste

4.0 Equipment/Apparatus

Balance

Crucible or Beaker

Heat Source

Flux Solvent

5.0 Procedure

5.1 Preparation

5.1.1 Weigh 10 to 50 grams (to the nearest 0.01 gram) of solder paste into a tared vessel suitable for melting the solder paste.

5.2 Test

5.2.1 Melt the solder at approximately 25°C above liquidus of the alloy, remove from heat and allow solder to solidify.

5.2.2 Extract melt from residual flux with a suitable solvent, dry and weigh metal to within 0.01 grams to determine % metal content.

5.3 Evaluation

$$\frac{\text{Weight of extracted metal}}{\text{Weight of original sample}} \times 100 = \%\ \text{Metal}$$

Enter the results in Table 1 ''Test Report on Solder Paste.''

Table 1 Test Report on Solder Paste

Enter appropriate information in top portion of report and complete report by entering the test results or checkmarks in the appropriate spaces.

Inspection Purpose:
__ Qualification
__ Quality Conformance A
__ Quality Conformance B
__ Shelf-Life Extension
__ Performance

QPL I.D. Number: ____________
Manufacturer's Identification: ____________
Manufacturer's Batch Number: ____________
Date of Manufacture: ____________
Original Use-By Date: ____________
Revised Use-By Date: ____________

Date Inspection Completed: ____________ Overall Results: __ Pass __ Fail
Inspection Performed by: ____________ Witnessed by: ____________

Inspections	User's Actual Requirement	Test Result	P/F (*)	Tested by & Date
Material				
Visual				
Metal Content				
Viscosity				
Solder Ball				
Slump				
Alloy				
Flux				
Powder Size				
% In Top Screen				
% In Next Screen				
% In Bottom Screen				
% In Receiver Bottom				
Max. Powder Size				
Powder Shape				
Tack				
Wetting				

* P/F = PASS/FAIL; enter P if test results are within tolerance of actual requirement; otherwise, enter F

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Number	
2.4.34	
Subject	
Solder Paste Viscosity—T-Bar Spin Spindle Method (Applicable for 300,000 to 1,600,000 centipoise)	
Date **1/95**	Revision
Originating Task Group **Solder Paste Task Group (5-24b)**	

1.0 Scope The test specifies a standard procedure for determining the viscosity of solder paste in the range of 300,000 to 1,600,000 centipoise.

2.0 Applicable Documents None

3.0 Test Specimen Paste to be tested shall be stabilized at 25°±1°C for a minimum of 24 hr. prior to testing. The paste volume shall be sufficient to fill a test container having a minimum diameter of 5 cm and a minimum depth of 5 cm.

4.0 Equipment/Apparatus The equipment used shall be a spindle type viscometer (Brookfield RVTD or equivalent) with a reversible helipath stand and pen recorder. A TF spindle shall be used for tests and operated at 5 rpm. Other equipment may be used provided the results can be empirically correlated as mutually agreed upon with the following test. Additional shear rates may be specified by the user or supplier provided one data point is based as specified below.

5.0 Procedure

5.1 Preparation

5.1.1 Open the supply container(s); remove any internal cover(s), scrape off paste adhering to the lid(s), internal covers, and the container walls; and add this material to the paste in the supply container(s).

5.1.2 Using a spatula, stir the paste gently for 1 to 2 minutes to homogenize it; taking care to avoid the introduction of air.

5.1.3 If necessary, gently transfer the paste to the test container having the specified volume; without introducing air. *Note:* If the supply container meets the volume and size requirements a separate test container is not needed.

5.1.4 The test container shall be placed in a constant temperature environment at 25 ±0.25°C. The solder paste shall remain stationary for a minimum of two hours to reach temperature and rheological equilibrium. For freshly manufactured products, products which require significant adjustment with thinner (greater than 1/2% by weight), or products having rheological characteristics requiring longer time to stabilize, the stabilization time shall be increased to four hours or as mutually agreed upon by user and supplier.

5.1.5 Set the bottom stop for helipath travel to position the T spindle at 2.8 cm below the surface of the solder paste in the test container. The bottom stop of the spindle shall be a minimum of 1 cm above the bottom of the container. Set the upper stop to position the spindle at 0.3 cm below the surface of the solder paste.

5.2 Test

5.2.1 Immerse the spindle in the solder paste and record data for 10 minutes (5 cycles). The temperature of the solder paste during the test shall be maintained at 25 +/–0.25°C.

5.3 Evaluation Viscosity is to be expressed at the value calculated from the average of the peak and valley of the last two cycles. If the average for the first two cycles is more than 10% higher than the last two cycles, the test is invalid and additional equilibrium time is required. Record data and enter in Table 1, ''Test Report on Solder Paste.''

6.0 Notes

6.1 Test Equipment Sources The equipment sources described below represent those currently known to the industry. Users of this test method are urged to submit additional source names as they become available, so that this list can be kept as current as possible.

6.1.1 Spindle Type Viscometer Equipment
Brookfield Engineering Laboratories, Inc.
240 Cushing Street
Stoughton, MA 02072
(617) 344-4310

Table 1 Test Report on Solder Paste

Enter appropriate information in top portion of report and complete report by entering the test results or checkmarks in the appropriate spaces.

Inspection Purpose:
__ Qualification
__ Quality Conformance A
__ Quality Conformance B
__ Shelf-Life Extension
__ Performance

QPL I.D. Number: ____________
Manufacturer's Identification: ____________
Manufacturer's Batch Number: ____________
Date of Manufacture: ____________
Original Use-By Date: ____________
Revised Use-By Date: ____________

Date Inspection Completed: ____________ Overall Results: __ Pass __ Fail
Inspection Performed by: ____________ Witnessed by: ____________

Inspections	User's Actual Requirement	Test Result	P/F (*)	Tested by & Date
Material				
Visual				
Metal Content				
Viscosity				
Solder Ball				
Slump				
Alloy				
Flux				
Powder Size				
% In Top Screen				
% In Next Screen				
% In Bottom Screen				
% In Receiver Bottom				
Max. Powder Size				
Powder Shape				
Tack				
Wetting				

* P/F = PASS/FAIL; enter P if test results are within tolerance of actual requirement; otherwise, enter F

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IPC-TM-650
TEST METHODS MANUAL

Number	
2.4.34.1	
Subject	
Solder Paste Viscosity—T-Bar Spindle Method (Applicable at less than 300,000 centipoise)	
Date **1/95**	Revision
Originating Task Group	
Solder Paste Task Group (5-24b)	

1.0 Scope This test specifies a standard procedure for determining the viscosity of solder paste in the range of 50,000 to 300,000 centipoise.

2.0 Applicable Documents None

3.0 Test Specimen Paste to be tested shall stabilize at 25°C±1°C for a minimum of 24 hours prior to testing. The paste volume shall be sufficient to fill a test container having a minimum diameter of 5 cm and a minimum depth of 5 cm.

4.0 Equipment/Apparatus Equipment used shall be a spindle type viscometer (Brookfield RVTD or equivalent) with a helipath stand and pen recorder. A TC spindle shall be used for tests. Spindle speed is 5 rpm. Other equipment may be used provided the results can be empirically correlated as mutually agreed upon with the following test. Additional shear rates may be specified by the user or supplier provided one data point is based as specified below.

5.0 Procedure

5.1 Preparation

5.1.1 Open the supply container(s); remove any internal cover(s); scrape off paste adhering to the lid(s), internal covers, and the container walls; and add this material to the paste in the supply container(s).

5.1.2 Using a spatula, stir the paste gently for 1 to 2 minutes to homogenize it; taking care to avoid the introduction of air.

5.1.3 If necessary, gently transfer the paste to the test container having the specified volume—without introducing air. Note: If the supply container meets the volume and size requirements, a separate test container is not needed.

5.1.4 The test container shall be placed in a constant temperature environment at 25°C±0.25°C.

5.1.5 After reaching 25°C±0.25°C, the solder paste shall be stirred and then tested within 20 minutes to minimize settling of the metal powder; while remaining at 25°C.

5.2 Test

5.2.1 Set the solder paste container below the spindle. Record data as the spindle penetrates the solder paste.

5.3 Evaluation The viscosity is calculated from the value recorded after the bar of the spindle comes in contact with the surface of the paste. Record the data in Table 1 ''Test Report on Solder Paste.''

6.0 Notes

6.1 Test Equipment Sources The equipment sources described below represent those currently known to the industry. Users of this test method are urged to submit additional source names as they become available, so that this list can be kept as current as possible.

6.1.1 Spindle Type Viscometer Equipment
Brookfield Engineering Laboratories, Inc.
240 Cushing Street
Stoughton, MA 02072
(617) 344-4310

Table 1 Test Report on Solder Paste

Enter appropriate information in top portion of report and complete report by entering the test results or checkmarks in the appropriate spaces.

Inspection Purpose:
__ Qualification
__ Quality Conformance A
__ Quality Conformance B
__ Shelf-Life Extension
__ Performance

QPL I.D. Number: ______
Manufacturer's Identification: ______
Manufacturer's Batch Number: ______
Date of Manufacture: ______
Original Use-By Date: ______
Revised Use-By Date: ______

Date Inspection Completed: ______ Overall Results: __ Pass __ Fail
Inspection Performed by: ______ Witnessed by: ______

Inspections	User's Actual Requirement	Test Result	P/F (*)	Tested by & Date
Material				
Visual				
Metal Content				
Viscosity				
Solder Ball				
Slump				
Alloy				
Flux				
Powder Size				
% In Top Screen				
% In Next Screen				
% In Bottom Screen				
% In Receiver Bottom				
Max. Powder Size				
Powder Shape				
Tack				
Wetting				

* P/F = PASS/FAIL; enter P if test results are within tolerance of actual requirement; otherwise, enter F

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Number	
2.4.34.2	
Subject	
Solder Paste Viscosity—Spiral Pump Method (Applicable for 300,000 to 1,600,000 centipoise)	
Date **1/95**	Revision
Originating Task Group **Solder Paste Task Group (5-24b)**	

1.0 Scope The test specifies a standard procedure for determining the viscosity of solder paste in the range of 300,000 to 1,600,000 centipoise.

2.0 Applicable Documents None

3.0 Test Specimen Paste to be tested shall be stabilized at 25°C±1°C for a minimum of 24 hours prior to testing. The paste volume shall be sufficient to fill the viscometer receptacle to about 60% of its depth.

4.0 Equipment/Apparatus The equipment used shall be a spiral pump viscometer (Malcom, Brookfield Viscometer or Rheometer with Spiral Adaptor accessory, or equivalent). Set the instrument rotational speed for 10 rpm. Other equipment may be used provided the results can be empirically correlated as mutually agreed upon. Additional shear rates may be specified by the user or supplier.

5.0 Procedure

5.1 Preparation

5.1.1 Open the container(s), remove any internal cover, scrape off paste adhering to the lids or internal cover(s) and the container wall(s) and add this to the paste in the container(s).

5.1.2 Using a spatula, stir the paste gently for 1 to 2 minutes to homogenize it, taking care to avoid the introduction of air.

5.1.3 Transfer sufficient paste to the viscometer receptacle to fill this to about 60% of its depth. Place the receptacle in the temperature controlled unit of the viscometer and allow it to stabilize at 25 +/–0.25°C for 15 minutes minimum.

5.2 Test

5.2.1 Immerse the instrument sensor into the sample in accordance with the equipment manufacturer's instructions. The solder paste should not cover the pump outlet.

5.2.2 Turn on chart recorder and set instrument to run at one specific shear rate. Take reading when output has been stable for at least 1 minute . If additional shear rates are to be measured, adjust the speed vernier and repeat above.

5.2.3 Record the viscosity measured at the single shear rate value. By mutual agreement between user and supplier multiple shear rates must be used to develop the solder paste shear sensitivity factor.

5.3 Evaluation Enter data in Table 1 ''Test Report on Solder Paste.''

6.0 Notes

6.1 Test Equipment Sources The equipment sources described below represent those currently known to the industry. Users of this test method are urged to submit additional source names as they become available, so that this list can be kept as current as possible.

6.1.1 Spiral Pump Viscometer Equipment
Brookfield Engineering Laboratories, Inc.
240 Cushing Street
Stoughton, MA 02072
(617) 344-4310

Malcom Instruments Corp.
26226 Industrial Blvd.
Hayward, CA 94545
(510) 293-0580
(510) 293-0584 - fax

6.2 Shear sensitivity factor is defined as the absolute value of the slope of a graph of the log viscosity versus log rpm.

Table 1 Test Report on Solder Paste

Enter appropriate information in top portion of report and complete report by entering the test results or checkmarks in the appropriate spaces.

Inspection Purpose:
__ Qualification
__ Quality Conformance A
__ Quality Conformance B
__ Shelf-Life Extension
__ Performance

QPL I.D. Number: ____________________
Manufacturer's Identification: ____________________
Manufacturer's Batch Number: ____________________
Date of Manufacture: ____________________
Original Use-By Date: ____________________
Revised Use-By Date: ____________________

Date Inspection Completed: ____________________ Overall Results: __ Pass __ Fail
Inspection Performed by: ____________________ Witnessed by: ____________________

Inspections	User's Actual Requirement	Test Result	P/F (*)	Tested by & Date
Material				
Visual				
Metal Content				
Viscosity				
Solder Ball				
Slump				
Alloy				
Flux				
Powder Size				
% In Top Screen				
% In Next Screen				
% In Bottom Screen				
% In Receiver Bottom				
Max. Powder Size				
Powder Shape				
Tack				
Wetting				

* P/F = PASS/FAIL; enter P if test results are within tolerance of actual requirement; otherwise, enter F

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IPC-TM-650 TEST METHODS MANUAL

Number	
2.4.34.3	
Subject	
Solder Paste Viscosity—Spiral Pump Method (Applicable at Less Than 300,000 centipoise)	
Date: 1/95	Revision
Originating Task Group	
Solder Paste Task Group (5-24b)	

1.0 Scope This test specifies a standard procedure for determining the viscosity of solder paste in the range of 50,000 to 300,000 centipoise.

2.0 Applicable Documents None

3.0 Test Specimen Paste to be tested shall be stabilized at 25°C±1°C for a minimum of 24 hours prior to testing. The paste volume shall be sufficient to fill the viscometer receptacle to about 60% of its depth.

4.0 Equipment/Apparatus The equipment used shall be a spiral pump viscometer (Malcom, Brookfield Viscometer or Rheometer with Spiral Adaptor accessory, or equivalent). Set the instrument rotational speed for 10 rpm. Other equipment may be used provided the results can be empirically correlated as mutually agreed upon. Additional shear rates may be specified by the user or supplier.

5.0 Procedure

5.1 Preparation

5.1.1 Open the container(s), remove any internal cover, scrape off paste adhering to the lids or internal cover(s) and the container wall(s) and add this to the paste in the container(s).

5.1.2 Using a spatula, stir the paste gently for 1 to 2 minutes to homogenize it, taking care to avoid the introduction of air.

5.1.3 Transfer sufficient paste to the viscometer receptacle to fill this to about 60% of its depth. Place the receptacle in the temperature controlled unit on the viscometer and allow it to stabilize at 25 +/–0.25°C for 15 minutes minimum and 15 minutes maximum.

5.2 Test

5.2.1 Immerse the instrument sensor into the sample in accordance with the equipment manufacturer's instructions. The solder paste shall not cover the pump outlet.

5.2.2 Turn on chart recorder and set instrument to run at one specific shear rate. Take reading when output has been stable for at least 1 minute.

5.3 Evaluation Record data in Table 1 ''Test Report on Solder Paste.''

6.0 Notes

6.1 Test Equipment Sources The equipment sources described below represent those currently known to the industry. Users of this test method are urged to submit additional source names as they become available, so that this list can be kept as current as possible.

6.1.1 Spiral Pump Viscometer Equipment
Brookfield Engineering Laboratories, Inc.
240 Cushing Street
Stoughton, MA 02072
(617) 344-4310

Malcom Instruments Corp.
26226 Industrial Blvd.
Hayward, CA 94545
(510) 293-0580
(510) 293-0584 - fax

Table 1 Test Report on Solder Paste

Enter appropriate information in top portion of report and complete report by entering the test results or checkmarks in the appropriate spaces.

Inspection Purpose:
__ Qualification
__ Quality Conformance A
__ Quality Conformance B
__ Shelf-Life Extension
__ Performance

QPL I.D. Number: ______
Manufacturer's Identification: ______
Manufacturer's Batch Number: ______
Date of Manufacture: ______
Original Use-By Date: ______
Revised Use-By Date: ______

Date Inspection Completed: ______ Overall Results: __ Pass __ Fail
Inspection Performed by: ______ Witnessed by: ______

Inspections	User's Actual Requirement	Test Result	P/F (*)	Tested by & Date
Material				
Visual				
Metal Content				
Viscosity				
Solder Ball				
Slump				
Alloy				
Flux				
Powder Size				
% In Top Screen				
% In Next Screen				
% In Bottom Screen				
% In Receiver Bottom				
Max. Powder Size				
Powder Shape				
Tack				
Wetting				

* P/F = PASS/FAIL; enter P if test results are within tolerance of actual requirement; otherwise, enter F

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IPC-TM-650 TEST METHODS MANUAL

Number	
2.4.35	
Subject	
Solder Paste—Slump Test	
Date	Revision
1/95	
Originating Task Group	
Solder Paste Task Group (5-24b)	

1.0 Scope This procedure determines vertical and horizontal slump for solder pastes.

2.0 Applicable Documents None

3.0 Test Specimen A standard specimen shall be prepared using a clean frosted glass microscope slide measuring 7.6 cm x 2.5 cm, minimum 1 mm thick. An equivalent alumina or glass epoxy substrate may be used.

4.0 Equipment/Apparatus

Stencils

IPC-A-21, IPC-A-20

Steel Squeegee (razor blade)

Oven

Microscope

5.0 Procedure

5.1 Preparation

5.1.1 Specimen preparation using appropriate stencil pattern IPC-A-21 or IPC-A-20. (Figures 1 & 2) Deposit solder paste patterns on 2 substrates for each stencil pattern. The printed pattern shall be uniform in thickness with no solder particles separated from the pads. The vendor and user should use the same printing method.

5.1.2 One test specimen shall be marked as specimen #1 and one specimen as #2 and processed in accordance with paragraphs 5.2.1 and 5.2.2.

5.2 Test

5.2.1 The specimens shall be stored for 10 to 20 minutes at 25 +/–5°C and 50% relative humidity +/–10% and specimen #1 examined for slump.

5.2.2 Specimen #2 from 5.2.1 shall be heated to 150 +/–10°C for 10 to 15 minutes, cooled to ambient and examined for slump.

5.3 Evaluation Enter data in Table 1 and/or Table 2 by entering spacings which have bridged with a suitable check mark.

Table 1

Stencil IPC-A-21 (0.2 mm Thick)					
Pad size 0.63 x 2.03 mm			Pad size 0.33 x 2.03 mm		
Spacing mm	Hor.	Vert.	Spacing mm	Hor.	Vert.
0.79			0.45		
0.71			0.40		
0.63			0.35		
0.56			0.30		
0.48			0.25		
0.41			0.20		
0.33			0.15		
			0.10		
			0.08		

Table 2

Stencil IPC-A-20 (0.1 mm Thick)					
Pad size 0.33 x 2.03 mm			Pad sie 0.2 x 2.03 mm		
Spacing mm	Hor.	Vert.	Spacing mm	Hor.	Vert.
0.45			0.30		
0.40			0.25		
0.35			0.20		
0.30			0.175		
0.25			0.15		
0.20			0.125		
0.15			0.10		
0.10			0.075		
0.08					

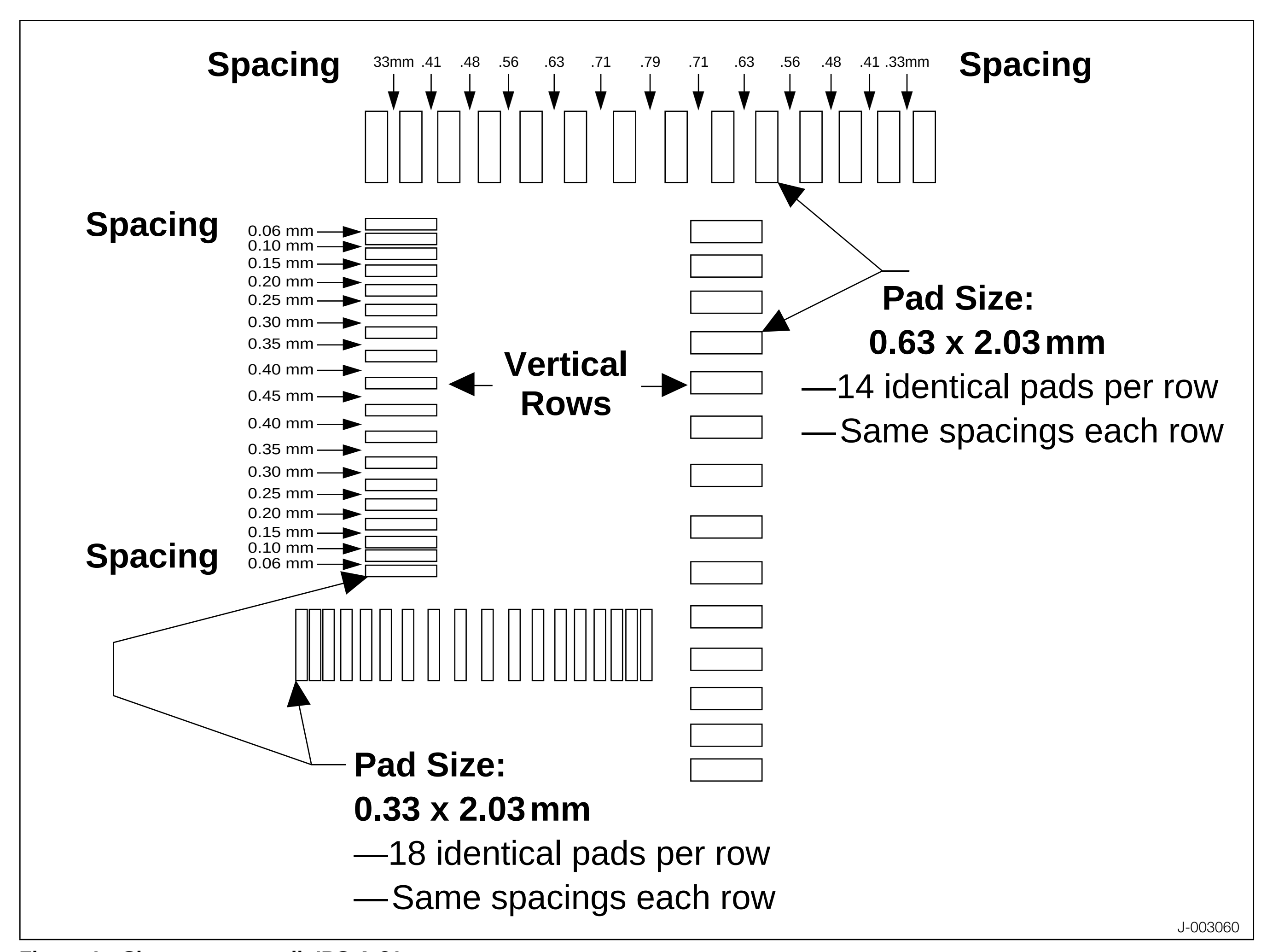


Figure 1 Slump test stencil, IPC-A-21

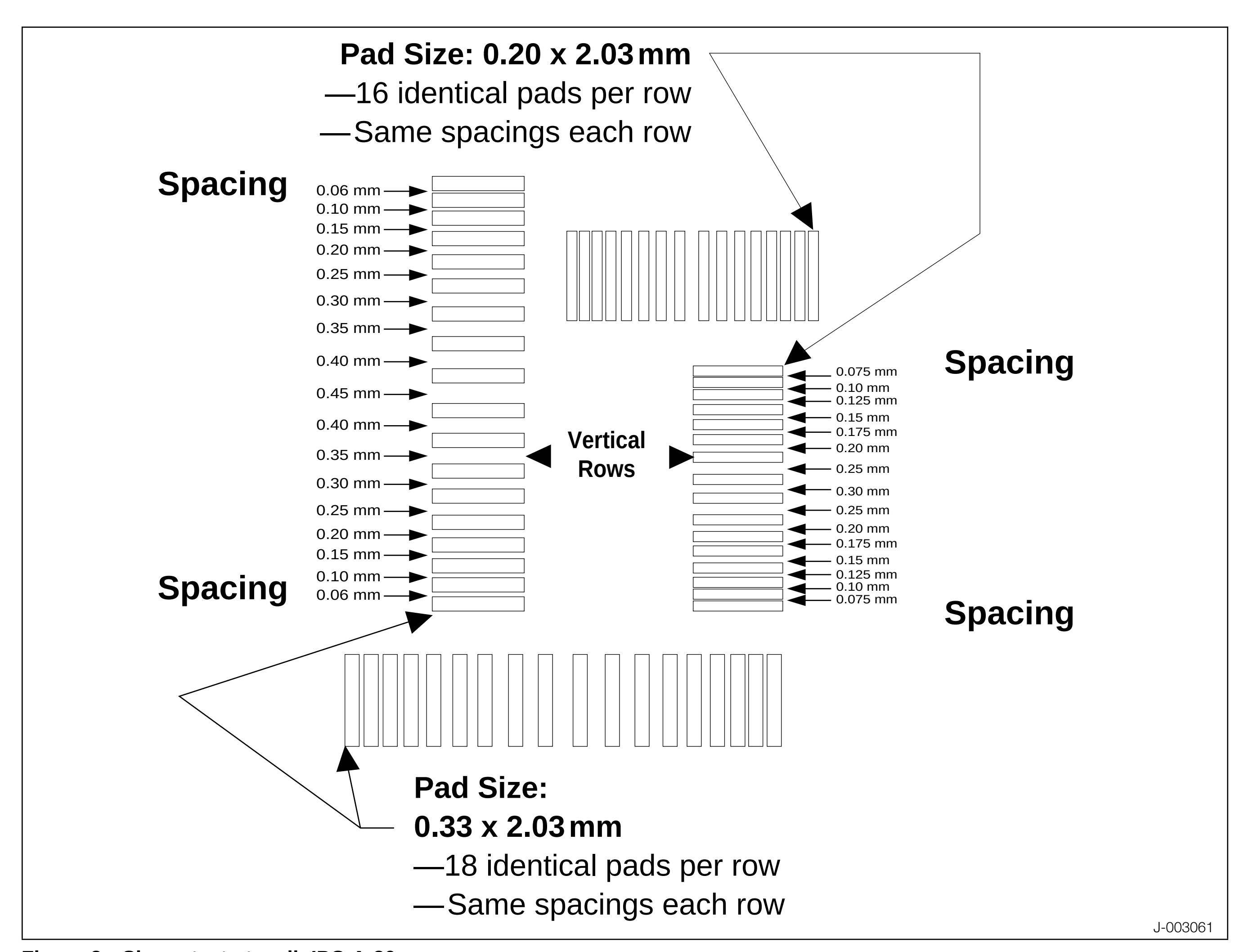


Figure 2 Slump test stencil, IPC-A-20

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IPC-TM-650
TEST METHODS MANUAL

Number	
2.4.43	
Subject	
Solder Paste—Solder Ball Test	
Date	Revision
1/95	
Originating Task Group	
Solder Paste Task Group (5-24b)	

1.0 Scope This test is carried out to determine the reflow properties of the solder paste. The ability of the prealloyed solder particles in the paste to reflow into a sphere on a non-wettable substrate is determined under defined test conditions.

2.0 Applicable Documents None

3.0 Test Specimen Frosted glass microscope slide, alumina substrate or glass/epoxy printed circuit board with a thickness of 0.60 to 0.80 mm and a minimum length and width dimension of 76 mm and 25 mm, respectively.

4.0 Equipment/Apparatus

4.1 Metal Stencils

4.1.1 Stencil for Type 1-4 Stencil 76 mm x 25 mm x 0.2 mm provided with at least 3 round holes of 6.5 mm diameter apertures with a minimum distance between centers of 10 mm.

4.1.2 Stencil for Type 5-6 Stencil 76 mm x 25 mm x 0.1 mm provided with at least 3 round holes of 1.5 mm diameter apertures with a minimum distance between centers of 10 mm.

4.2 Spatula

4.3 Solder bath not less than 100 mm x 100 mm x 75 mm deep containing solder suitable to maintain a temperature of 25°C above the liquidus temperature of the solder paste being evaluated.

4.4 Flat hot plate

4.5 Surface temperature thermometer

4.6 Magnifying glass with a 10 to 20 times magnification.

5.0 Procedure

5.1 Preparation

5.1.1 Set the temperature of the solder bath or hot plate at a temperature of 25°C +/–3°C above the liquidus temperature of the solder alloy.

5.1.2 Homogenize the solder paste by hand stirring with a spatula.

5.1.3 Condition the paste to uniform temperature of 25° C +/–2°C.

5.1.4 Prepare two test specimens with either/or both stencils listed above (4.1.1 and 4.1.2). The solder paste should be squeeged with the spatula to fill and level each hole.

5.2 Test

5.2.1 Test Conditions

5.2.1.1 Test one specimen within 15 +/–5 minutes after placement of solder paste on test coupon.

5.2.1.2 Test the second specimen 4 hours +/–15 minutes after placement of solder paste on test coupon. Storage for 4 hours shall be at 25°C +/–3°C and 50 +/–10% RH.

5.2.2 Conditioning Heating Equipment

5.2.2.1 Clean the surface of the solder bath with the scraper.

5.2.2.2 Remove all foreign material from the surface of the hot plate to ensure proper control.

5.2.3 Solder Reflow Reflow specimens by one of the following two methods.

5.2.3.1 Lower the substrate, in a horizontal position with the paste deposit on top, into the solder bath at a speed of 25 +/–2 mm/second until the substrate is 50% submerged. It is important that good thermal contact is achieved between the molten solder and the substrate. As soon as the solder has melted, withdraw the substrate from the solder bath maintaining it in a horizontal position. The total time on the solder bath shall not exceed 20 seconds.

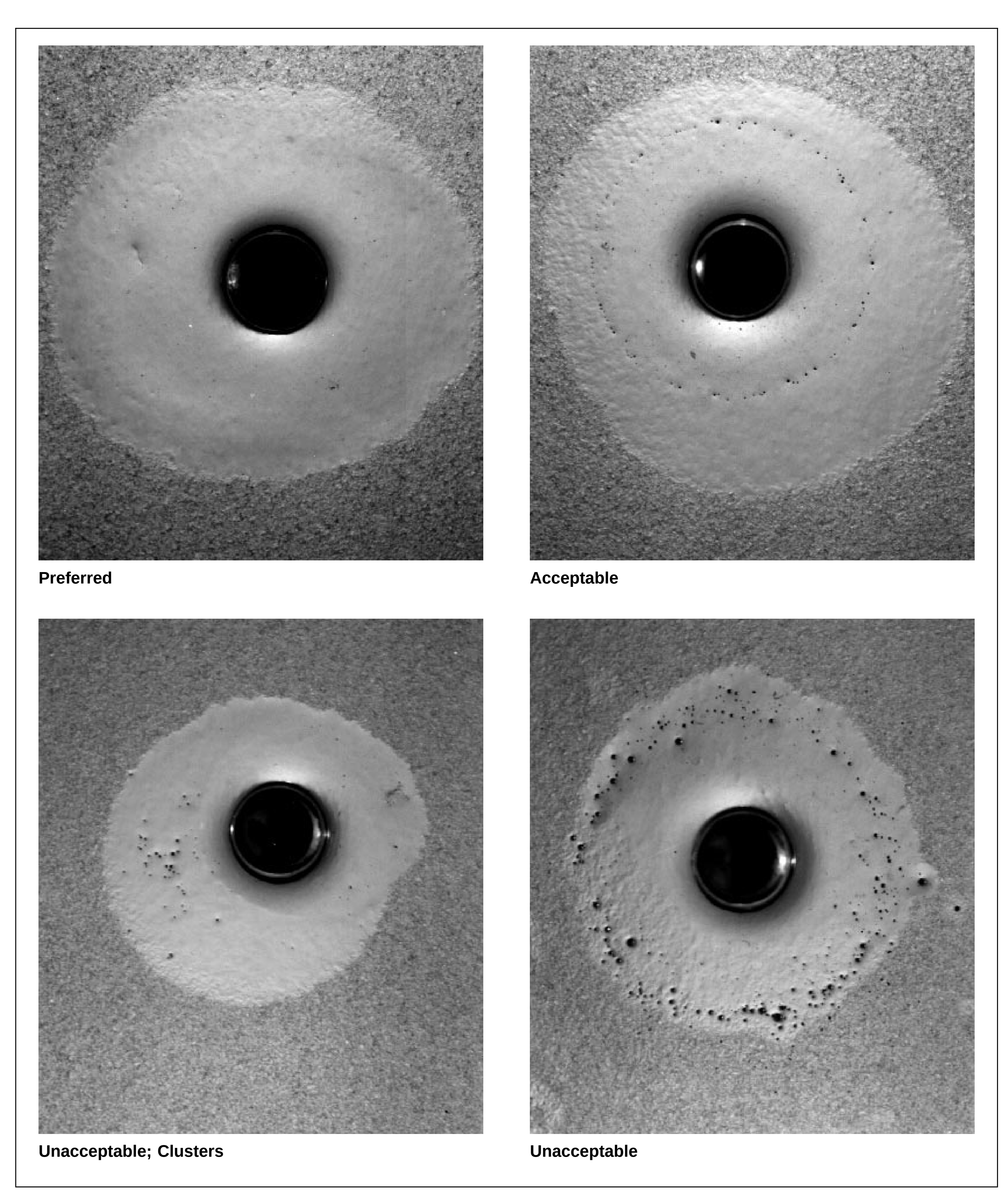
5.2.3.2 Place the substrate on the hot plate. As soon as the solder has melted, withdraw the substrate from the hot plate maintaining a horizontal position. The reflow shall occur within 20 seconds after the specimen is placed in contact with the hot plate.

5.3 Evaluation

5.3.1 Examine the reflowed specimens under 10X to 20X magnification.

5.3.2 Solder ball size and number should be compared with Figure 1.

5.3.3 Record the degree of reflow in comparison with Figure 1 for the 6.5 cm and 1.5 cm acceptance/reject conditions, respectively.



Preferred

Acceptable

Unacceptable; Clusters

Unacceptable

Figure 1 Solder ball test standards

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IPC-TM-650
TEST METHODS MANUAL

Number	
2.4.44	
Subject	
Solder Paste—Tack Test	
Date	Revision
1/95	
Originating Task Group	
Solder Paste Task Group (5-24b)	

1.0 Scope This test is to determine the ability of a printed pattern of solder paste to retain a probe placed in the solder paste by measuring the force required to separate the probe from the paste. Time between printing and probe placement are progressively increased to simulate variables in a manufacturing process.

2.0 Applicable Documents None

3.0 Test Specimen Prepare a test specimen and mark in a suitable manner to identify the sample and the time after printing when tackiness is to be measured. The prepared samples shall be stored at 25 +/–2°C and 50 +/–10% RH until evaluated. The samples shall not be stored in an enclosed cabinet or container which allows the solder paste solvent vapors to saturate the environment surrounding the printed paste, thus preventing natural drying of the material.

4.0 Equipment/Apparatus A Chatillon tackiness tester may be used, or other equipment, providing it is capable of accurately measuring force when tested at a similar velocity. The equipment shall have a stainless steel test probe with a nominal 5.1 +/–0.13 mm diameter bottom surface which is smooth, flat and aligned parallel to the plane of the subject test specimen. The probe shall contact the test specimen at a controlled speed and apply a controlled, fixed initial contact force. Finally, a means shall be provided to withdraw the test probe from the surface of the test specimen at a controlled speed and to record the peak force required to break contact with the test specimen.

5.0 Procedure Place the specimen slide under the test probe and center the probe over one of the three printed patterns. Bring the test probe in contact with the printed paste specimen at a rate of 2.5 +/–0.5 mm/min. and apply a force of 300 +/–30 grams to the specimen. Within 5 seconds following application of this force, withdraw the probe from the specimen at a rate of 2.5 +/–0.5 mm/min. and record the peak force required to break the contact. Take at least five additional measurements under the same test conditions and average all the readings. Record both the tack force and time following paste printing.

5.1 Evaluation Initial measurements are to be taken immediately after printing. Subsequent measurements of force shall be taken as needed to best define the rise and decline of the tack force. Tackiness data should be presented in graph form, provided that the graph with tack force is plotted as a function of time after printing. The data can also be reported as follows:

1. Time to reach 80% of the peak value;
2. The peak tack force in grams with the expected variation;
3. Time over which the peak value is maintained or for the tack force to decline to 80% of its peak value.

6.0 Notes

6.1 Test Equipment Sources The equipment sources described below represent those currently known to the industry. Users of this test method are urged to submit additional source names as they become available so that this list can be kept as current as possible.

6.1.1
Tackiness Testers
Part No. x3207
Chatillon
Greensboro, NC
(800) 527-9999

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IPC-TM-650
TEST METHODS MANUAL

Number	
2.4.45	
Subject	
Solder Paste—Wetting Test	
Date **1/95**	Revision
Originating Task Group	
Solder Paste Task Group (5-24b)	

1.0 Scope Determine the ability of a solder paste to wet an oxidized copper surface and to qualitatively examine the amount of spatter of the solder paste during reflow.

2.0 Applicable Documents None

IPC-TM-650 Test Methods Manual

2.4.43 Solder Paste—Solder Ball Test

3.0 Test Specimen

7.6 cm x 2.5 cm x 0.8 mm specimen of 1 ounce oxygen-free high conductivity (OFHC) copper.

4.0 Equipment/Materials/Apparatus

Flat hot plate

Specimen tongs

Beaker 400 cc

Magnifying glass with 10 times magnification

Liquid copper cleaner

Deionized water

Isopropyl alcohol

Solvent for residual flux removal

4.1 Stencil 76 mm x 25 mm x 0.2 mm provided with at least 3 round holes or 6.5 mm diameter aperature with a minimum between centers of 10 mm.

5.0 Procedure

5.1 Preparation

5.1.1 The specimen shall be cleaned with a liquid copper cleaner, washed thoroughly with water, rinsed with isopropyl alcohol, dried and then placed in boiling deionized water for 10 minutes and air dried

5.2 Test

5.2.1 Place stencil on test specimen and print solder paste test pattern.

5.2.2 Reflow using the procedure outlined in paragraph 5.2.3.2 of IPC-TM-650, Test Method 2.4.43.

5.2.3 After reflow, the residual flux shall be removed with a suitable solvent.

5.3 Evaluation When examined visually at 10X, the solder shall uniformly wet the copper and there should be no evidence of dewetting or non-wetting of the copper and there shall be no solder spatter around the printed dots.



Standard Improvement Form

J-STD-005

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1. I recommend changes to the following:

___ Requirement, paragraph number __________

___ Test Method number __________, paragraph number __________

The referenced paragraph number has proven to be:

___ Unclear ___ Too Rigid ___ In Error

___ Other ______________________________

2. Recommendations for correction:

____

____

____

____

3. Other suggestions for document improvement:

____

____

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Submitted by:

Name ______________________________ Telephone __________

Company ______________________________

Address ______________________________

City/State/Zip ______________________________ Date __________

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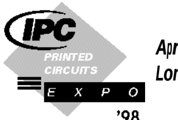
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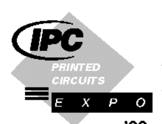
For more information, contact John Riley
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e-mail: rilejo@ipc.org http://www.ipc.org/html/610.htm

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- ☐ purchasing/manufacturing printed circuit assemblies

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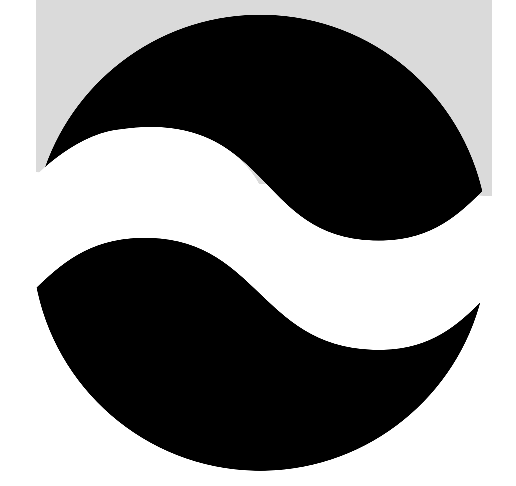
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J–STD-005
JANUARY 1995
Amendment 1 June 1996

JOINT INDUSTRY STANDARD

Requirements for Soldering Pastes

Amendment 1







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The material in this joint standard was developed by the Solder Alloy Task Group (5-24c).

For Technical Information Contact:

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Engineering Department
2500 Wilson Boulevard
Arlington, VA 22201
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Fax (703) 907-7501

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Please use the Standard Improvement Form shown at the end of this document.

Requirements for Soldering Pastes Amendment 1

Para. 1.1 First paragraph, insert at end: Solder paste buyers are referred to 6.3 for a listing of requirements information and options which should be addressed when preparing an order for J-STD-005 solder pastes.

Para. 2.2 Delete without replacement.

Para. 2.3 Delete and substitute:

ISO 9001 Quality Systems − Model for Quality Assurance in Design, Development, Production, Installation and Servicing.

ISO 9002 Quality Systems − Model for Quality Assurance in Production, Installation and Servicing.

Table 2A Second column, delete entire column and substitute:

Less Than 0.005% Larger Than
180 microns
90 microns
53 microns

Table 2B Second column, delete entire column and substitute:

Less Than 0.005% Larger Than
45 microns
32 microns
25 microns

Para 3.2 Delete and substitute

3.2 Description of Product The description of a solder paste product should identify all applicable characteristics, such as: alloy, flux, powder, metal content, viscosity, unit packae size, etc. The description system in Table 1 may be used to consisely describe standard solder paste products and to partially describe non-standard solder paste products. Complete description of non-standard solder paste products usually requires the use of tabular or narrative format, because the number of possible variations in characteristics cannot be easily coded into a consise format.

Table 1 System To Describe Solder Paste Products
Description Format: AAAAABCCCCDEEFFFFGGG

(Substitute Solder Paste Product Characteristic identifiers for the Description Format Symbols in accordance with the following.)

Format Symbol	Solder Paste Product Characteristic
AAAAA	Alloy Shortname from Table A-1 of J-STD-006
B	Solder Form[1] - P for all solder paste products
CCCC	Flux designator from Table 1 of J-STD-004
D	Powder type designation from Table 2A or 2B
EE	Metal content in percent by mass (e.g., 91, 92)
FFFF	Viscosity in kilo centipoise (e.g., 0800, 1000)
GGG	Package unit mass in kilogram (e.g., 0.5, 001, 010)

Note: [1] The Solder Form code is used to distinguish between various solder forms which use similiar description formats.

Para. 3.10 Add under b., at end of sentence: ''(see 3.2, Table 1)''

Delete ''g. Percent metal.''

Para. 4.1.1.1 Delete ''ISO 9002,'' and substitute ''ISO 9001, ISO 9002,''.

Para. 4.1.2 Delete ''MIL-STD-45662'' and substitute ''ISO 10012 Part 1.''

Figure 4 Delete and substitute:

Test Report on Solder Paste

(Enter appropriate information in top portion of report and complete report by entering the test results or checkmarks in the appropriate spaces.)

Inspection Purpose:

___ Qualification

___ Shelf-Life Extension

___ Performance

Manufacturer's Identification____________________

Manufacturer's Batch Number____________________

Date of Manufacture____________________

Original USE-By Date:____________________

Revised USE-By Date:____________________

Date Inspection Completed:____________________ Overall Results: ___ Pass ___ Fail

Inspection performed by: ____________________ Witnessd by:____________________

Inspections	Requirement Paragraph	Test Method	User's Actual Requirement	Test Result	P/F (*)	Tested by & Date
Material						
Visual						
Metal Content	3.4	2.2.20				
Viscosity	3.5	2.4.34, 2.4.31.1, 2.4.34.2, 2.4.34.3				
Solder Ball	3.7	2.4.43				
Slump	3.6	2.4.35				
Alloy						
Flux						
Powder Size	3.3	2.2.14, 2.2.14.2, 2.2.14.1, 2.2.14.3				
%in Top Screen						
% in Next Screen						
% in Bottom Screen						
% in Receiver Bottom						
Max. Powder Size	3.3.2.1	2.2.14.3				
Powder Shape	3.3.3.1					
Tack	3.8	2.4.44				
Wetting	3.9	2.4.45				

*P/F = Pass/Fail; enter P if test results are within tolerance of actual requirement; otherwise, enter F.

Figure 4 Solder Paste Inspection Report Form

Para 6.3 Insert new paragraph as follows:

6.3 Acquisition Requirements Acquisition documents should specify the following:

a. Number, revision, title, and date of this standard

b. Alloy designation (see 3.2)

c. Flux type (see 3.2.2)

d. Standard powder size number (see 3.3.2, Tables 2A and 2B), or size characteristics of non-standard powder

e. Powder shape, if different (see 3.3.3)

f. Metal percent

g. Viscosity (see 3.5)

h. Slump test, if required (see 3.6)

i. Solder ball test, if required (see 3.7)

j. Tack test, if required (see 3.8)

k. Wetting test, if required (see 3.9)

l. Marking requirements, if different (see 3.10)

m. Qualification and quality conformance inspections, if different (see 4.1)

n. Qualification and quality conformance procedures, if different (see 4.1.1)

o. Preservation, packing, packaging, and exterior marking requirements, if different (see 5.0)

TEST METHOD 2.2.14.3

Table 1 Delete second column and substitute:

1st
180
90
53
45
32
25

Table 2

Delete "QPL I.D. Number: ________".
Delete the "A" from "Quality Conformance A".
Delete "Quality Conformance B".

TEST METHOD 2.2.20

Table 1

Delete "QPL I.D. Number: ________".
Delete the "A" from "Quality Conformance A".
Delete "Quality Conformance B".

TEST METHOD 2.4.34

Table 1

Delete "QPL I.D. Number: ________".
Delete the "A" from "Quality Conformance A".
Delete "Quality Conformance B".

TEST METHOD 2.4.34.1

Table 1

Delete "QPL I.D. Number: ________".
Delete the "A" from "Quality Conformance A".
Delete "Quality Conformance B".

Para. 6.0 Delete "approximate" and substitute "appropriate".

TEST METHOD 2.4.34.2

Table 1

Delete "QPL I.D. Number: ________".
Delete the "A" from "Quality Conformance A".
Delete "Quality Conformance B".

TEST METHOD 2.4.34.3

Table 1

Delete "QPL I.D. Number: ________".
Delete the "A" from "Quality Conformance A".
Delete "Quality Conformance B".



Standard Improvement Form

J-STD-005

The purpose of this form is to provide the Technical Committee of IPC with input from the industry regarding usage of the subject standard.

Individuals or companies are invited to submit comments to IPC. All comments will be collected and dispersed to the appropriate committee(s).

If you can provide input, please complete this form and return to:

IPC
2215 Sanders Road
Northbrook, IL 60062-6135
Fax 847 509.9798

1. I recommend changes to the following:

___ Requirement, paragraph number __________

___ Test Method number __________, paragraph number __________

The referenced paragraph number has proven to be:

___ Unclear ___ Too Rigid ___ In Error

___ Other ____

2. Recommendations for correction:

____

____

____

____

3. Other suggestions for document improvement:

____

____

____

____

Submitted by:

Name ____________________ Telephone ____________________

Company ____________________ E-mail ____________________

Address ____

City/State/Zip ____________________ Date ____________________

Technical Questions

The IPC staff will research your technical question and attempt to find an appropriate specification interpretation or technical response. Please send your technical query to the technical department via:

tel 847/509-9700 fax 847/509-9798
http://www.ipc.org e-mail: answers@ipc.org

IPC Technical Forums

IPC technical forums are opportunities to network on the Internet. It's the best way to get the help you need today! Over 2,500 people are already taking advantage of the excellent peer networking available through e-mail forums provided by IPC. Members use them to get timely, relevant answers to their technical questions.

TechNet@ipc.org

TechNet forum is for discussion of technical help, comments or questions on IPC specifications, or other technical inquiries. IPC also uses TechNet to announce meetings, important technical issues, surveys, etc.

ChipNet@ipc.org

ChipNet forum is for discussion of flip chip and related chip scale semiconductor packaging technologies. It is cosponsored by the National Electronics Manufacturing Initiative (NEMI).

ComplianceNet@ipc.org

ComplianceNet forum covers environmental, safety and related regulations or issues.

DesignerCouncil@ipc.org

Designers Council forum covers information on upcoming IPC Designers Council activities as well as information, comment, and feedback on current design issues,local chapter meetings, new chapters forming, and other design topics.

Roadmap@ipc.org

The IPC Roadmap forum is the communication vehicle used by members of the Technical Working Groups (TWGs) who develop the IPC National Technology Roadmap for Electronic Interconnections.

IPCsm840@ipc.org

This peer networking forum is specific to solder mask qualification and use.

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To: LISTSERV@IPC.ORG
Subject:
Message: subscribe TechNet Joseph H. Smith

Example for signing off:
To: LISTSERV@IPC.ORG
Subject:
Message: sign off DesignerCouncil

Please note you must send messages to the mail list address ONLY from the e-mail address to which you want to apply changes. In other words,if you want to sign off the mail list, you must send the signoff command from the address that you want removed from the mail list. Many participants find it helpful to signoff a list when travelling or on vacation and to resubscribe when back in the office.

How to post to a forum:

To send a message to all the people currently subscribed to the list, just send to <mail list>@ipc.org Please note, use the mail list address that you want to reach in place of the <mail list> string in the above instructions.

Example:
To: TechNet@IPC.ORG
Subject: <your subject>
Message: <your message>

The associated e-mail message text will be distributed to everyone on the list, including the sender. Further information on how to access previous messages sent to the forums will be provided upon subscribing.

For more information, contact Dmitriy Sklyar
tel 847/509-9700 x311 fax 847/509-9798
e-mail: sklydm@ipc.org http://www.ipc.org/html/forum.htm

IPC World Wide Web Page http://www.ipc.org

Our home page provides access to information about upcoming events, publications and videos, membership, and industry activities and services. Visit soon and often.

Education and Training

IPC conducts local educational workshops and national conferences to help you better understand emerging technologies. National conferences have covered Ball Grid Array and Flip Chip/Chip Scale Packaging. Some workshop topics include:

- Printed Wiring Board Fundamentals
- Troubleshooting the PWB Manufacturing Process
- Choosing the Right Base Material Laminate
- Acceptability of Printed Boards
- New Design Standards
- High Speed Design
- Design for Manufacturability
- Design for Assembly
- Designers Certification Preparation

IPC video tapes and CD-ROMs can increase your industry know-how and on the job effectiveness.

For more information on programs, contact John Riley
tel 847/509-9700 ext. 308 fax 847/509-9798
e-mail: rilejo@ipc.org http://www.ipc.org

For more information on IPC Video/CD Training, contact Mark Pritchard
tel 505/758-7937 ext. 202 fax 505/758-7938
e-mail: markp@taos.newmex.com
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Training and Certification

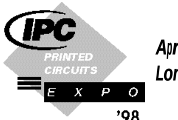
IPC-A-610 Training and Certification Program

"The Acceptability of Electronic Assemblies" (ANSI/IPC-A-610) is the most widely used specification for the PWB assembly industry. An industry consensus Training and Certification program based on the IPC-A-610 is available to your company.

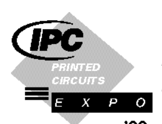
For more information, contact John Riley
tel 847/509-9700 ext. 308 fax 847/509-9798
e-mail: rilejo@ipc.org http://www.ipc.org/html/610.htm

IPC Printed Circuits Expo

IPC Printed Circuits Expo is the largest trade exhibition in North America devoted to the PWB industry. Over 90 technical presentations make up this superior technical conference.



April 28-30, 1998
Long Beach, California



March 16-18, 1999
Long Beach, California

For more information, contact Kim Behr
tel 847/509-9700 ext. 319 fax 847/509-9798
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How to Get Involved

The first step is to join IPC. An application for membership can be found on page 74.

Once you become a member, the opportunities to enhance your competitiveness are vast. Join a technical committee and

learn from our industry's best while you help develop the standards for our industry. Participate in market research programs which forecast the future of our industry. Participate in Capitol Hill Day and lobby your Congressmen and Senators for better industry support. Pick from a wide variety of educational opportunities: workshops, tutorials, and conferences. More up-to-date details on IPC opportunities can be found on our web page: http:/www.ipc.org.

For information on how to get involved, contact:
Jeanette Ferdman, Membership Manager
tel 847/509-9700 ext. 309 fax 847/509-9798
e-mail: JeanetteFerdman@ipc.org http://www.ipc.org



Application for Site Membership

Please check appropriate category

Thank you for your decision to join IPC members on the "Intelligent Path to Competitiveness"! IPC Membership is **site specific,** which means that IPC member benefits are available to all individuals employed at the site designated on the other side of this application.

To help IPC serve your member site in the most efficient manner possible, please tell us what your facility does by choosing the most appropriate member category.

■ Independent Printed Board Manufacturers

Our facility manufactures and sells to other companies, printed wiring boards or other electronic interconnection products on the merchant market.

What products do you make for sale?

- ☐ One-sided and two-sided rigid printed boards
- ☐ Multilayer printed boards
- ☐ Flexible printed boards
- ☐ Flat cable
- ☐ Hybrid circuits
- ☐ Discrete wiring devices
- ☐ Other interconnections

Name of Chief Executive Officer/President_______________________________________

■ Independent Printed Board Assemblers EMSI companies

Our facility assembles printed wiring boards on a contract basis and/or offers other electronic interconnection products for sale.

- ☐ Turnkey
- ☐ SMT
- ☐ Chip Scale Technology
- ☐ Through-hole
- ☐ Mixed Technology
- ☐ Consignment
- ☐ BGA

Name of Chief Executive Officer/President_______________________________________

■ OEM – Manufacturers of any end product using PCB/PCAs or Captive Manufacturers of PCBs/PCAs

Our facility purchases, uses and/or manufactures printed wiring boards or other electronic interconnection products for our own use in a final product. Also known as original equipment manufacturers (OEM).

Is your interest in:

- ☐ purchasing/manufacture of printed circuit boards
- ☐ purchasing/manufacturing printed circuit assemblies

What is your company's main product line? _______________________________________

■ Industry Suppliers

Our facility supplies raw materials, machinery, equipment or services used in the manufacture or assembly of electronic interconnection products.

What products do you supply?_______________________________________

■ Government Agencies/ Academic Technical Liaisons

We are representatives of a government agency, university, college, technical institute who are directly concerned with design, research, and utilization of electronic interconnection devices. (Must be a non-profit or not-for-profit organization.)

Please be sure both sides of this application are correctly completed

IPC APPLICATION FOR SITE MEMBERSHIP

Site Information:

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City ____________________ State ________ Zip ________ Country ________

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Primary Contact Name ____________________

Title ____________________ Mail Stop ____________________

Phone ____________________ Fax ____________________ e-mail ____________________

Alternate Contact Name ____________________

Title ____________________ Mail Stop ____________________

Phone ____________________ Fax ____________________ e-mail ____________________

Please check one:

❑ $1,000.00 Annual dues for Primary Site Membership (Twelve months of IPC membership begins from the time the application and payment are received)

❑ $800.00 Annual dues for Additional Facility Membership: Additional membership for a site within an organization where another site is considered to be the primary IPC member.

❑ $600.00** Annual dues for an independent PCB/PWA fabricator or independent EMSI provider with annual sales of less than $1,000,000.00. **Please provide proof of annual sales.

❑ $250.00 Annual dues for Government Agency/University/not-for-profit organization

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AMRC Membership ❑ Please send me information for Membership in the Assembly Marketing Research Council (AMRC)

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